REMARKS

Claims 1-26 are pending. Claims 1-26 stand rejected. Claims 1-26 remain in the application.

Claims 1-2, 12, and 16-17 stand rejected under 35 U.S.C. 102(b) as being anticipated by Murayama (US Patent 5, 936, 684). The rejection stated in relation to Claims 1 and 12:

> "Regarding claims 1 and 12: Murayama discloses determining M reconstruction levels (M<N) based on the gray level distribution of the N level image, each said reconstruction level being calculated using respective pixels of said N level image (figure 4 and column 9, lines 34-39 of Murayama); and applying multilevel error diffusion (column 14, lines 56-62 of Murayama) to the N level digital image using the M reconstruction levels to produce the M level digital image (figures 8-9 and column 12, lines 58-62 of Murayama).
>
> "Further regarding claim 12: Murayama discloses that the multitone processing method is performed using a computer program (column 14, lines 63-67 of Murayama)."

Claim 1 states:

> 1. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:
>
> a) determining M reconstruction levels based on the gray level distribution of the N level image; and
>
> b) applying multilevel error diffusion to the N level digital image using the M reconstruction levels to produce the M level digital image;
>
> wherein said determining further comprises assigning all of the pixels of said N level image into M groups corresponding to said M reconstruction levels and, following said assigning, calculating each of said M reconstruction levels using the pixels of the respective said group.

Claim 1 is supported by the application as filed, notably by the original claims and at page 4, lines 11-14 and 19-29.

Claim 1 requires that the determining step includes:

"assigning all of the pixels of said N level image into M groups corresponding to said M reconstruction levels and, following said assigning, calculating each of said M reconstruction levels using the pixels of the respective said group".

In Murayama, there is no assigning of all of the input image pixels into groups prior to the calculating of reconstruction levels. In Murayama, a first threshold is calculated directly from a set of pixel values, and additional thresholds are calculated from the first threshold:

"Next, in step s4 of FIG. 1, other threshold values are determined based on this first threshold value th[1]." (Murayama, col. 8, lines 23-24)

Revankar is similar to Murayama in this respect and unlike Claim 1:

"Step 3: Use threshold T_1 to divide the histogram into two sub histograms as in step 2 and find thresholds TJ1 and TJN for each sub histogram". (Revankar, col. 5, lines 10-12)

"In the proposed method, the histogram (original sample) is recursively cut into two pieces, and with each recursion smaller samples and less reliable thresholds are generated". (Revankar, col. 5, lines 51-54)

"Histogram J(i) is recursively thresholded at recursive threshold processor 304." (Revankar, col. 6, lines 56-57)

Claim 12 is allowable as depending from Claim 1.

The rejection stated in relation to Claim 16:

"Regarding claim 16: Murayama discloses clustering pixel values (figure 4 of Murayama) of the N level image into M (M<N) reconstruction levels (column 9, lines 34-39 of Murayama) based on the gray level distribution of the N level image (figures 2a-2b and column 9, lines 38-45 of Murayama); and minimizing error between the N level digital image and the M level digital image during said clustering (figure 2b; figure 5(S23); column 8, lines 44-49; and column 10, lines 22-24 and equation 5 of Murayama). Two methods are used to minimize the error between the N level digital image and the M level digital image during said clustering. The first method is to evenly distribute the threshold values based on the cumulative histogram (figure 2b and column 8, lines 44-49 of Murayama). The second method is to maximize the interclass-

variance (figure 5(S23) and column 10, lines 22-24 and equation 5 of Murayama), which also distributes the threshold values as evenly as possible, thus minimizing the error between the N level digital image and the M level digital image during said clustering."

Claim 16 states:

16. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:

clustering all of the pixel values of the N level image into M reconstruction levels based on the gray level distribution of the N level image;

repeatedly revising said clustering of said pixel values into said reconstruction levels until error between the N level digital image and the M level digital image is minimized; and

applying multilevel error diffusion to the N level digital image using said M reconstruction levels to produce the M level digital image.

Claim 16 is supported by the application as filed, notably the original claims and at page 4, lines 19-28.

Claim 16 requires that the all of the pixel values of the N level image are clustered into M reconstruction levels based on the gray level distribution of the N level image and that this clustering is repeatedly revised until error between the N level digital image and the M level digital image is minimized. Murayama does not teach or suggest such repeated revision. The portions of Murayama cited in relation to "error minimization" relate to steps that precede the "clustering" step. This precludes clustering followed by revising until error is minimized.

Now reviewing the rejection in detail, the rejection cites portions of Murayama relating to:

<u>step s5</u> (n value conversion process) of Murayama, Figure 1,

<u>step s2</u> (Computation of average and standard deviation of brightness of second class),

<u>step s3</u> (Computation of first threshold value: th[1]), and

step s4 (Computation of second threshold value: th[2] through n-1st threshold value th[n-1]).

The rejection looks to step s5, discussed at Murayama, col. 9, lines 34-39 and Figure 4, in relation to clustering. The cited section is part of a larger discussion of step s5 of Murayama, Figure 1:

> "When the first through n-1st threshold values have been determined in this manner, an n value conversion process is then accomplished (step s5). Hereafter, this n value conversion process will be described with reference to FIG. 3. The flowchart in FIG. 3 shows an n value conversion process for one particular pixel." (Murayama, col. 8, lines 62-67)
>
> "Furthermore, the same process is accomplished for the next pixel. FIG. 4 shows the relationship between the respective brightness values (0 -255) of the pixels being processed, the first through third threshold values ..." (Murayama, col. 9, lines 33-36)

The rejection looks to steps s2, s3, and s4 in relation to minimizing error. The rejection cites Murayama, Figure 5 (S23), col. 10, lines 22-24 and equation 5. All of these relate to S23, which is part of step s2 of Figure 1. (See legends on Figure 5: "FROM STEP S1 OF FIG.1" at the top and "GO TO S3 IN FIG. 1" at the bottom.) The rejection also cites col. 8, lines 44-49. This is a discussion of step s4 of Figure 1. (See Murayama, col. 8, lines 23-49) The rejection cites Figure 2b, which shows setting of the threshold values. This relates to steps s3 and s4.

In Murayama, step s5 follows steps s2-s4. This is not compatible with the language of Claim 16.

Revankar is cited in the rejection in relation to other claims. Unlike Claim 16, Revankar does not teach clustering all of the pixel values of the N level image into M reconstruction levels based on the gray level distribution of the N level image followed by repeatedly revising the clustering of those pixel values into the M reconstruction levels. Revankar describes a thresholding process as being recursive, but that process adds additional thresholds (which would add additional reconstruction levels) at each recursion. Revankar states:

> "In the proposed method, the histogram (original sample) is recursively cut into two pieces, and with each recursion smaller samples and less reliable thresholds are generated". (Revankar, col. 5, lines 51-54)

"Histogram H(i) is recursively thresholded at recursive threshold processor 304. The output of this processor are the threshold values and the goodness function." (Revankar, col. 6, lines 56-59)

The rejection stated in relation to Claims 2 and 17:

> "Regarding claims 2 and 17: Murayama discloses performing a K-means clustering operation on the N level digital image, wherein K=M (column 8, lines 37-43 of Murayama). The number of cumulative pixels for increasing brightness in the histogram (figure 2b of Murayama) are used to determine the threshold values (column 8, lines 39-43 of Murayama). The total number of cumulative pixels are divided by the number of levels (M, or n in Murayama) that are used for the image reconstruction (column 8, lines 37-38 of Murayama), and thus the number of clusters (K) is equal to the number of reconstruction levels (M)."

The Office Action also stated:

> "Regarding page 7, line 7 to page 8, line 4: Applicant is respectfully reminded that Examiner is required to give the broadest reasonable interpretation of the claims consistent with the specification (see MPEP §904.1). Despite the quote from the application cited in Applicant's present arguments, Applicant has not attempted to act as own lexicographer. Therefore, the broadest reasonable interpretation of "K-means clustering operation" has been given. In Murayama (US Patent 5,936,684), there are K clusters provided based on K threshold values derived from the calculated histogram."

Claim 2 states:

> 2. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:
>
> a) determining M reconstruction levels based on the gray level distribution of the N level image; and
>
> b) applying multilevel dithering to the N level digital image using the M reconstruction levels to produce the M level digital image;
>
> wherein the determining step comprises performing a K-means clustering operation on the N level digital image, wherein K = M.

Claim 2 was rewritten as an independent claim and is supported by the application as filed, notably the original claims.

In the prior amendment, Applicants cited the specification in relation to the meaning of the term "K-means clustering":

> "Referring to Fig. 2, there is shown the steps of the K-means clustering technique. First, the number of clusters K is selected to be equal to M 21. Then initial values for the K cluster centers are chosen 22 either randomly or uniformly spaced in the range of pixel values of the input digital image. Next, each pixel is assigned 23 to the closest cluster center according to the Euclidean distance, which corresponds to minimization of the mean squared error. Cluster centers are then recalculated 24 using all the pixel values assigned to each cluster center. Next, a pre-determined stopping condition is checked 25. One example of a stopping condition is when the changes in the cluster centers are below a predetermined threshold. If the pre-determined stopping condition is not met, steps 23 and 24 are repeated. Otherwise, the K-means clustering process is stopped 26. For more details about the K-means algorithm, see Tou and Gonzalez, Pattern Recognition Principles, Reading MA: Addison-Wesley, 1974. These K cluster means are used as the M optimal reconstruction levels to produce an M level output image." (application, page 4, line 18 to page 5, line 1; also see Figure 2)

The Office Action responded:

> 'Despite the quote from the application cited in Applicant's present arguments, Applicant has not attempted to act as his own lexicographer. Therefore, the broadest reasonable interpretation of "K-means clustering operation" has been given.'

The Office Action fails to follow established law. Under *Phillips v. AWH Corp.*, 415 F.3d 1303; 2005 U.S. App. LEXIS 13954; 75 USPQ.2d 1321, (Fed. Cir., 2005), the specification of an application must be considered in determining the meaning of claim terms, even if there is no express definition. *Phillips* states:

> '[I]n particular requiring that any definition of claim language in the specification be express, is inconsistent with our rulings that the specification is "the single best guide to the meaning of a disputed term," and that the specification "acts as a dictionary when it expressly defines

terms used in the claims or when it defines terms by implication.'" *Phillips v. AWH Corp.*, quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996)

The specification, as the above quote from the application shows, provides a specific meaning for the term "K-means clustering".

The meaning given to the term "K-means clustering" in the application is also the customary meaning of that term in the art. *Pattern Classification*, 2nd ed., R.O. Duda, P.E. Hart, D.G. Stork, John Wiley & Sons, Inc., New York, (2001) states:

> **"10.4.3 *k*-Means Clustering**
>
> "Of the various techniques that can be used to simplify the computation and accelerate convergence, we shall briefly consider one elementary but very popular approximate method. We are tempted to call it the *c*-means procedure, since its goal is to find the *c* mean vectors $\boldsymbol{\mu}_1, \boldsymbol{\mu}_2, \ldots, \boldsymbol{\mu}_c$. However, it is much more widely known as *k*-means clustering, where k (which is the same as our c) is the number of cluster centers. [Section continues with a description of the technique]" (page 526)
>
> **"Algorithm 1. (*k*-Means Clustering)**

```
1 begin initialize n, c, μ1, μ2, ..., μc
2         do classify n samples according to nearest μi
3                 recompute μi
4         until no change in μi
5     return μ1, μ2, ..., μc
6 end"  (page 527)
```

"K-means clustering", as the term is used in the application, is provided by the function "kmeans" in the software product "Statistics Toolbox 5.1" for MATLAB® marketed by The MathWorks, Inc., of Natick, Massachusetts. (Described generally in Datasheet [online]. The MathWorks, Inc., of Natick, Massachusetts [retrieved on 2005-09-26]. Retrieved from the Internet at www.mathworks.com/products/statistics/ .) Detailed features of the kmeans function and K-means clustering are discussed in:

> "kmeans :: Functions (Statistics Toolbox)" [online]. The MathWorks, Inc., Natick, Massachusetts [retrieved on 2005-09-26]. Retrieved from the Internet at www.mathworks.com/access/helpdesk/help/toolbox/stats/

and in

> "K-Means Clustering :: Multivariate Statistics (Statistics Toolbox)" [online]. The MathWorks, Inc., Natick, Massachusetts [retrieved on 2005-09-26]. Retrieved from the Internet at www.mathworks.com/access/helpdesk/help/toolbox/stats/ .

Another definition of "K-means clustering" that is also in agreement with the application is provided in:

> "K-Means Clustering Algorithm -- From MathWorld" [online]. Wolfram Research, Inc., Champaign, Illinois [retrieved on 2005-09-26]. Retrieved from the Internet at //mathworld.wolfram.com/K-meansClusteringAlgorithm.html .

Murayama fails to disclose use of K-means clustering.

Claim 17 is allowable as depending from Claim 16 and on the same grounds as Claim 2.

Claims 3-6, 13, and 18 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Ishiguro (US Patent 6,501,566 B1). The rejection stated in relation to Claim 3:

> "Regarding claim 3: Murayama discloses determining M reconstruction levels (M<N) based on the gray level distribution of the N level image (figure 4 and column 9, lines 34-39 of Murayama); applying multilevel error diffusion (column 14, lines 56-62 of Murayama) to the column 12, lines 58-62 of Murayama); and forming a histogram of the N level digital image (figure 2a and column 7, lines 26-31 of Murayama).
>
> "Murayama does not disclose expressly locating said M reconstruction levels corresponding to the M most prominent peaks in the histogram. Ishiguro discloses locating M reconstruction levels (denoted by N in Ishiguro) (column 3, lines 24-25 of Ishiguro) corresponding to the M most prominent peaks in the histogram (figure 7 and column 7, lines 23-26 and lines 59-65 of Ishiguro). A histogram is created (figure 7 and column 7, lines 23-26 of Ishiguro) which set the pixel reference levels based on the number of pixels with densities within a set range (figure 7 and column 7, lines 59-65 of Ishiguro). As can clearly be seen from figure 7 of Ishiguro, this results in the four density levels (SO to S3) corresponding to the four most prominent peaks in the histogram. This is

further evidenced by the language of claim 14 of Ishiguro (column 10, lines 57-60 of Ishiguro).

> "Murayama and Ishiguro are combinable because they are from the same field of endeavor, namely digital image binarization. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to set the M levels (M<N), taught by both Murayama and Ishiguro, based on the M most prominent peaks of said histogram, as taught by Ishiguro. The motivation for doing so would have been to prevent degradation of the image quality when error diffusion is performed, which is a common result for predetermined threshold values (column 2, lines 57-65 of Ishiguro). Therefore, it would have been obvious to combine Ishiguro with Murayama to obtain the invention as specified in claim 3."

The Office Action also stated:

> "Regarding page 8, line 5 to page 10, line 16: Merely using a different type of histogram would clearly be obvious to one of ordinary skill in the art at the time of the invention. Using a non-cumulative histogram, such as taught by Ishiguro (US Patent 6,501,566 B1), instead of a cumulative histogram, such as taught by Murayama, is a trivial use of an optional mathematical representation of data. Further, Applicant is respectfully reminded that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See In re Keller, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). In this case, the teachings of Ishiguro would have suggested to one of ordinary skill in the art at the time of the invention to use a non-cumulative histogram to detect peaks. In fact, both histograms can be used in an analysis of the image data since a histogram is simply a useful mathematical means by which data is represented. There is no requirement that only a cumulative or a non-cumulative histogram be used. In fact, the use of both would clearly have been

advantageous to one of ordinary skill in the art at the time of the invention since both representations of the data provide different perspectives.

"Regarding page 10, line 17 to page 11, line 13: By the very nature of the fact that Ishiguro is a single patent, Ishiguro teaches a system that is complete and whole unto itself. However, particular teachings can nonetheless be taken from Ishiguro to modify the system taught by Murayama, thus providing an improved result. The solution presented by Ishiguro is based upon the specific teachings and problems that were solved by Ishiguro. One of ordinary skill in the art at the time of the invention would clearly have desired to use what was learned by Ishiguro in solving other problems. In the case presented in said previous office action, the problem to be solved, which Murayama does not completely solve, is how to best determine the M reconstruction levels. Ishiguro provides the solution, which can then be incorporated into the teachings of Murayama. While Applicant may wonder why anyone would bother to combine Ishiguro with Murayama, it is sufficient that Examiner has demonstrated adequate motivation to combine. There are things that Murayama can do that Ishiguro cannot and things that Ishiguro can do that Murayama cannot do. Practitioners in the art require a variety of different teachings so that they may try new creative ideas and develop new systems and processes, rather than simply using only what is readily available."

Claim 3 states:

3. A method for multitone processing an N level digital image to produce an M level digital image wherein $M<N$, comprising the steps of:

a) determining M reconstruction levels based on the gray level distribution of the N level image; and

b) applying multilevel error diffusion to the N level digital image using said M reconstruction levels to produce the M level digital image;

wherein the determining step comprises forming a histogram of the N level digital image and locating said M reconstruction levels corresponding to the M most prominent peaks in the histogram.

The rejection has not presented a teaching or suggestion supporting the combination of the two cited references. The stated motivation is based upon a subjective criterion: "which is a common result".

The rejection proposed motivation for combining Murayama and Ishiguro:

> "The motivation for doing so would have been to prevent degradation of the image quality when error diffusion is performed, which is a common result for predetermined threshold values (column 2, lines 57-65 of Ishiguro)."

The cited portion of Ishiguro is a quotation from the Background of the Invention, which presents a problem in the prior art.

> "However, the conventional multi-value error diffusion process circuit had the disadvantage that the quality of the image data is degraded since the entire original document is subjected to the error diffusion process with a predetermined threshold value. For example, when there is a halftone image of uniform density in the original data such as halftone density text and that uniform density differs from the predetermined threshold value, data resolution is reduced to degrade the picture quality of the image." (Ishiguro, col. 2, lines 57-65)

Ishiguro solves the indicated problem:

> "An object of the present invention is to provide a image processing apparatus that can carry out an error diffusion process without degrading the quality of the image data." (Ishiguro, col. 3, lines 9-11)

The problem and solution stated in Ishiguro provide motivation for one of skill in the art to use Ishiguro to solve the problem of Ishiguro. This is not in and of itself motivation to use Ishiguro in combination with another reference.

The rejection does mention that the degradation of the problem solved by Ishiguro is "a common result for predetermined threshold values". This statement is subjective argument, which is not supported by the references. The cited language from Ishiguro describes a disadvantage of "the conventional multi-value error diffusion process circuit"; that term refers to a specific circuit, which is shown in Figures 10-14 described in great detail at col. 1, line 22 to col. 2, line 56. (See particularly, col. 1, lines 22-23 which states: "FIG. 10 is a block diagram showing a structure of <u>a conventional multi-value error diffusion process</u>

circuit."; emphasis added) The rejection has made no showing that this circuit has any relationship to Murayama or that this circuit supports the terminology "a common result". In view of this, withdrawal of the rejection or presentation of documentary support for the proposed "common result" is demanded. (See MPEP 2144.03)

The rejection is also overcome by its failure to address the factual showing in the previous amendment, which stated:

> 'Murayama and Ishiguro do not combine to teach the claimed invention. Murayama and Ishiguro teach two different types of histograms. Murayama teaches the setting of thresholds based upon a cumulative frequency distribution as shown by the cumulative histogram of Figures 2(a) and 2(b). (Murayama, col. 6, lines 42-44; col. 7, lines 25-27) Ishiguro discloses setting a threshold using a non-cumulative histogram of pixel densities. (Isihiguro, col. 7, lines 23-26) Murayama uses the cumulative frequency distribution of the cumulative histogram to meet the object of the invention of Murayama:
>
> > "Hence, it is an object of the invention to provide an image processing method and apparatus which can set threshold values for achieving a desired number of gradations, i.e., color shades or gray-scale, via a simple process when an image processed with a high number of gradations is displayed on a display unit having a low number of gradations, and can set the desired number of gradations without shading being noticeable, even for images having shading.
> >
> > "In order to achieve the above objects, the image processing method of the invention is of the type of image processing method wherein image data, having a brightness range in designated gradations and including at least a background and meaningful information existing in the background, is converted to image data in n gradations (n>2), with n differing from the designated gradations. The cumulative frequency distribution of the pixels is determined for each brightness range in the designated gradations. The average brightness and standard deviation of the part wherein the background is predominant are determined from

this cumulative frequency distribution. A first threshold value that is an indicator of the boundary between the background and the meaningful information is determined on the basis of the average brightness and standard deviation." (Murayama, col. 2, lines 16-39; emphasis added)

In Ishiguro the threshold can be changed, as desired:

"Furthermore, the pixel of a particular density can be enhanced or the number of out gray levels can be adjusted by intentionally altering the condition for setting the threshold value (for example, by arbitrary setting by user)." (Ishiguro, col. 9, lines 31-35; emphasis added)

Assuming that one of skill in the art were motivated to combine Murayama and Ishiguro, the above-quoted portions to those references would provide motivation to use the process of Ishiguro with thresholds set by the cumulative frequency distribution and cumulative histogram of Murayama. This contradicts the rejection, which proposes the opposite.'

Applicants have shown motivation in the cited references for a combination, which would not teach or suggest the claimed invention. The Patent Office must consider the cited art as a whole. The burden is on the Patent Office to overcome this motivation.

The Office Action argues that motivation for combining the references is the knowledge of one of skill in the art:

"[B]oth histograms can be used in an analysis of the image data since a histogram is simply a useful mathematical means by which data is represented. There is no requirement that only a cumulative or a non-cumulative histogram be used. In fact, the use of both would clearly have been advantageous to one of ordinary skill in the art at the time of the invention since both representations of the data provide different perspectives."

The Office Action also states:

"The solution presented by Ishiguro is based upon the specific teachings and problems that were solved by Ishiguro. One of ordinary skill in the art at the time of the invention would clearly have desired to use what was learned by Ishiguro in solving other problems."

The Office Action later states:

> "There are things that Murayama can do that Ishiguro cannot and things that Ishiguro can do that Murayama cannot do. Practitioners in the art require a variety of different teachings so that they may try new creative ideas and develop new systems and processes, rather than simply using only what is readily available."

The rejection's position is against established law and USPTO practice. MPEP 2143.01 states:

> 'FACT THAT THE CLAIMED INVENTION IS WITHIN THE CAPABILITIES OF ONE OF ORDINARY SKILL IN THE ART IS NOT SUFFICIENT BY ITSELF TO ESTABLISH PRIMA FACIE OBVIOUSNESS
>
> 'A statement that modifications of the prior art to meet the claimed invention would have been " 'well within the ordinary skill of the art at the time the claimed invention was made' " because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references. Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). See also In re Kotzab, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1318 (Fed. Cir. 2000) (Court reversed obviousness rejection involving technologically simple concept because there was no finding as to the principle or specific understanding within the knowledge of a skilled artisan that would have motivated the skilled artisan to make the claimed invention); Al-Site Corp. v. VSI Int'l Inc., 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999) (The level of skill in the art cannot be relied upon to provide the suggestion to combine references.).'

Claims 4-6, 13, and 18 are allowable as depending from Claims 1, 3, and 16, respectively.

Claims 7 and 19 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Eschbach (US Patent 5,565,994). Claims 8, 10-11 and 20 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Eschbach and Klassen (US Patent 5, 621, 546). Claims 7-8 and 10-11 are allowable as depending from Claim 1 and on grounds discussed

above in relation to Claim 2, which are applicable to the current combination of references. Claims 19-20 are allowable as depending from Claim 16 and on grounds discussed in relation to Claim 2, which are applicable to the current combination of references.

Claim 9 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Klassen. Claim 9 is allowable as depending from Claim 1.

Claim 14 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Ishiguro and Eschbach. Claim 14 is allowable as depending from Claim 3.

Claim 15 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Ishiguro, Eschbach, and Klassen. Claim 15 is allowable as depending from Claim 3.

Claims 21-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Revankar (US Patent 5,649,025). The rejections stated:

> "Regarding claim 21: Murayama discloses assigning pixels of the N level digital image to the M cluster centers to provide assigned pixels (column 8, lines 44-49 of Murayama); calculating values of said cluster centers based upon respective said assigned pixel (figure 4 and column 9, lines 34-45 of Murayama); selecting final values of said cluster centers as reconstruction levels (figure 4 and column 9, lines 34-39 of Murayama); and applying multilevel error diffusion (column 14, lines 56-62 of Murayama) to the N level digital image using said reconstruction levels to produce the M level digital image (figures 8-9 and column 12, lines 58-62 of Murayama).
>
> "Murayama does not disclose expressly setting initial values of M cluster centers; and repeating said assigning and said calculating until a predetermined stopping condition is reached and, thereby, final values of said cluster centers are defined.
>
> "Revankar discloses setting initial values of M cluster centers (column 5, lines 6-9 of Revankar); and repeating the overall threshold operations (figure 6(304,306) and column 6, lines 56-65 of Revankar) until a predetermined stopping condition is reached (column 7,

lines 1-5 of Revankar) and, thereby, final values of said cluster centers are defined (column 7, lines 1-5 of Revankar).

"Murayama and Revankar are combinable because they are from the same field of endeavor, namely digital image data threshold determination. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to iteratively perform the threshold determination, as taught by Revankar, thus initially setting the value of the M cluster centers and repeating said assigning and calculating steps taught by Murayama until a predetermined stopping condition is reached, as taught by Revankar. The motivation for doing so would have been that different portions, or segments, of an image can be better halftoned if multiple thresholds are applied to each region, rather than a single global thresholding (column 2, lines 25-31 of Revankar). Therefore, it would have been obvious to combine Revankar with Murayama to obtain the invention as specified in claim 21."

Claim 21 states:

21. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:

setting initial values of M cluster centers;

assigning pixels of the N level digital image to said cluster centers to provide assigned pixels;

calculating new values of said cluster centers based upon respective said assigned pixels;

repeating said assigning and calculating until a predetermined stopping condition is reached and, thereby, final values of said cluster centers are defined;

selecting said final values of said cluster centers as reconstruction levels; and

applying multilevel error diffusion to the N level digital image using said reconstruction levels to produce the M level digital image.

Claim 21 was amended to correct a typographical error.

The rejection argues that motivation for combining the cited references:

> "would have been that different portions, or segments, of an image can be better halftoned if multiple thresholds are applied to each region, rather than a single global thresholding (column 2, lines 25-31 of Revankar)."

Murayama shows segmenting of an intensity histogram into two parts (see Figure 2(a)), followed by applying multiple thresholds to one of the regions (see Figure 2(b)). One of skill in the art would not be motivated to combine Murayama with another reference in order to provide a feature that was already present. This leaves the proposed motivation for combining the references as applying multiple thresholds to each region, since Murayama already teaches applying multiple thresholds in one region. One of skill in the art would also not be motivated to combine Murayama with Revankar, because applying multiple thresholds to each of the two initial regions in Murayama would render Murayama non-functional or degraded.

Murayama states:

> "Hence, it is an object of the invention to provide an image processing method and apparatus which can set threshold values for achieving a desired number of gradations, i.e., color shades or gray-scale, via a simple process when an image processed with a high number of gradations is displayed on a display unit having a low number of gradations, and can set the desired number of gradations without shading being noticeable, even for images having shading." (Murayama, col. 2, lines 16-23; emphasis added)
>
> "As explained above, in accordance with the invention, when image data with numerous values is converted into image data having a small number of gradations, it is possible to determine the first through n-1st (n>2) threshold values by merely adding a slight computation to the so-called Ohtsu method." (Murayama, col. 15, lines 1-6)
>
> "In addition, for images having shading that are photographed by an area sensor such as, for example, a CCD camera, a determination is made as to whether the pixels thereof are background or are meaningful information. In the case of background pixels, an n value

conversion process is accomplished using a method that obtains two-dimensional gradations. When the pixel comprises meaningful information, such as characters, an n value conversion process is accomplished using the above-described first through n-1st threshold values. Accordingly, a process is accomplished which preserves the edges in, for example, characters. Also, it is possible to accomplish an n value conversion process that reduces the effects of shading for information such as the background." (Murayama, col. 15, lines 14-27)

In contrast, the proposed combination of the rejection would add additional computations and additional thresholds applicable to the background pixels. (See Murayama, col. 2, lines 31-37)

The rejection states:

"Murayama does not disclose expressly setting initial values of M cluster centers; and repeating said assigning and said calculating until a predetermined stopping condition is reached and, thereby, final values of said cluster centers are defined.

"Revankar discloses setting initial values of M cluster centers (column 5, lines 6-9 of Revankar); and repeating the overall threshold operations (figure 6(304,306) and column 6, lines 56-65 of Revankar) until a predetermined stopping condition is reached (column 7, lines 1-5 of Revankar)"

Claim 21, unlike Murayama and Revankar, requires setting initial values of M cluster centers, assigning pixels of the N level digital image to the M ("said") cluster centers, calculating new values of M ("said") cluster centers, and repeating until a stopping condition is reached. As discussed in relation to Claim 1, in Revankar the number of partitions and thresholds (and cluster centers) increases recursively--Revankar recursively divides the histogram into sub histograms and finds additional thresholds for each sub histogram. (Revankar, col. 5, lines 10-12 and 51-54)

Claims 22-23 are allowable as depending from an allowable claim. The rejection stated in relation to Claim 22:

Regarding claim 22: Murayama discloses that said assigning minimizes respective mean squared error (figure 5(S23) and column 10, lines 22-24 and equation 5 of Murayama). Maximizing the

interclass variance (figure 5(S23) and column 10, lines 22-24 and equation 5 of Murayama), distributes the threshold values as evenly as possible. Since the equation for variance is based on the square of the difference between the respective classes figure 5(23) and column 10, equation 5 of Murayama), the respective mean squared error is minimized.

Claim 22 states:

> 22. The method of claim 21 wherein said assigning minimizes respective mean squared error.

Claim 22 is also allowable on grounds similar to those discussed above in relation to Claim 16. The rejection of Claim 21 indicates that the "assigning" of Claim 21 is taught by part of step 4 of Figure 1 of Murayama (See Murayama, col. 8, lines 23-61. The rejection of Claim 22 indicates that the minimizing of mean squared error is taught by Murayama, Figure 5 (S23), col. 10, lines 22-24 and equation 5. All of these relate to S23, which is part of step s2 of Figure 1. (See legends on Figure 5: "FROM STEP S1 OF FIG.1" at the top and "GO TO S3 IN FIG. 1" at the bottom.) In Murayama, step s5 follows steps s2. This is not compatible with the language of Claim 22. The recursion of Revankar would not change this, since the number of partitions and thresholds (and cluster centers) would increase recursively.

Claim 24 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Revankar and Ishiguro. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Revankar and Eschbach. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Revankar, Eschbach, and Klassen. Claims 24-26 are allowable as depending from Claim 21.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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